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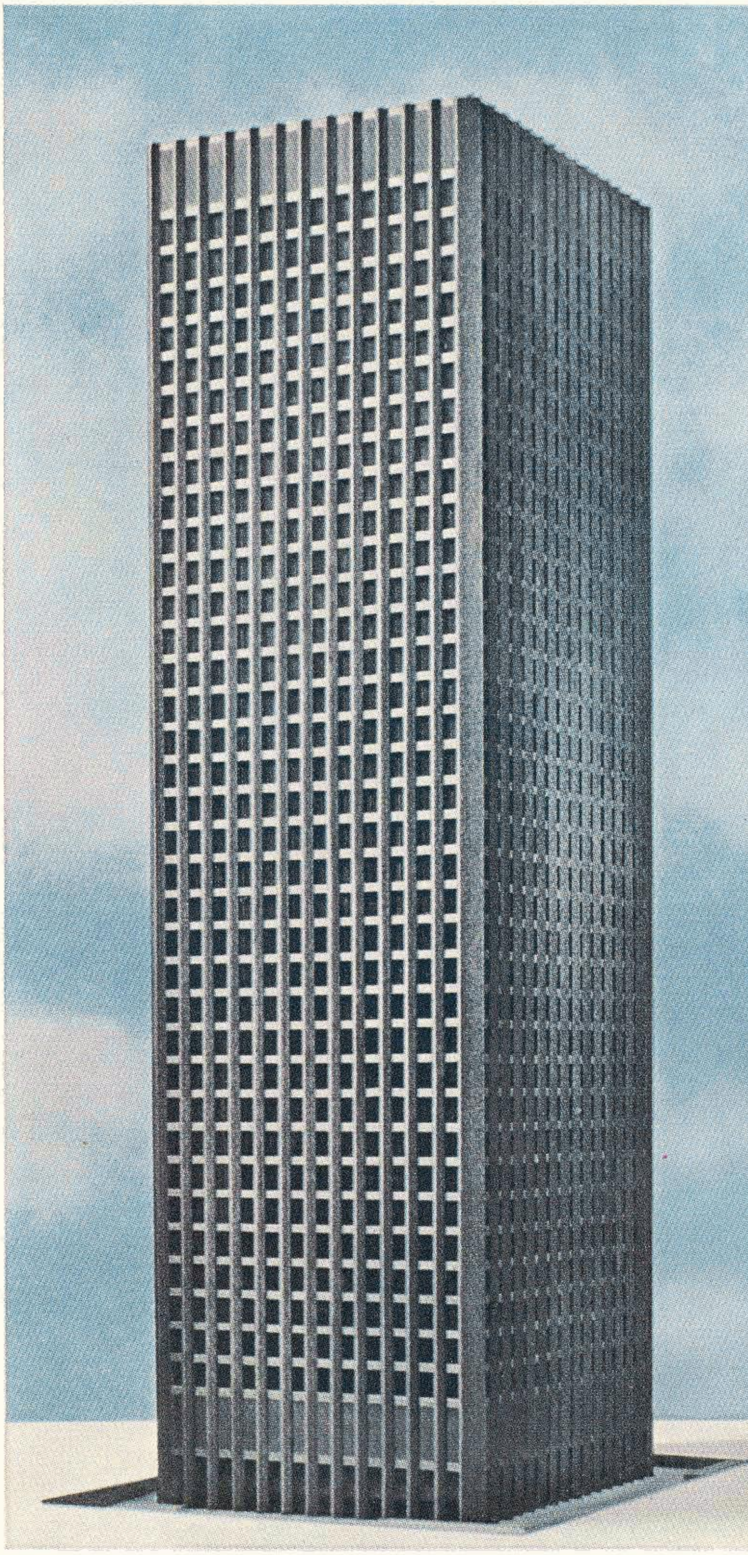

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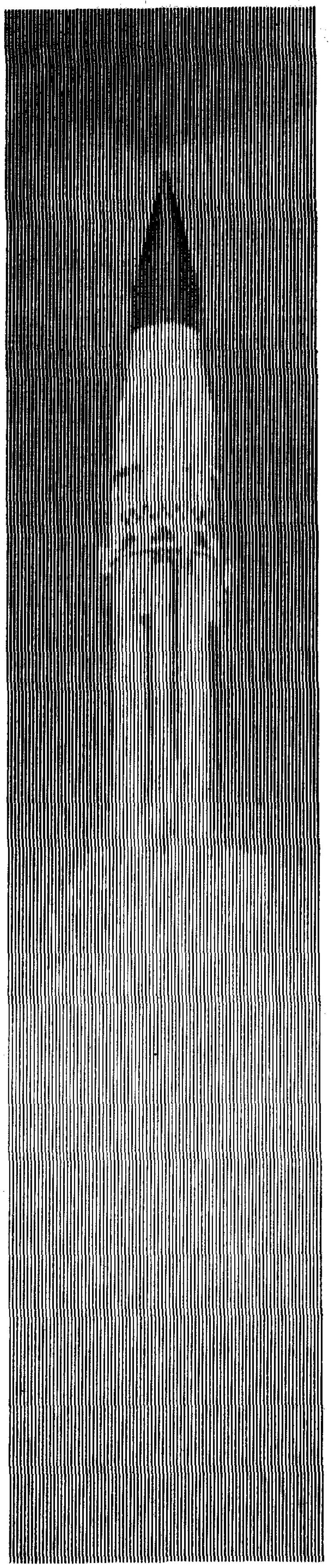

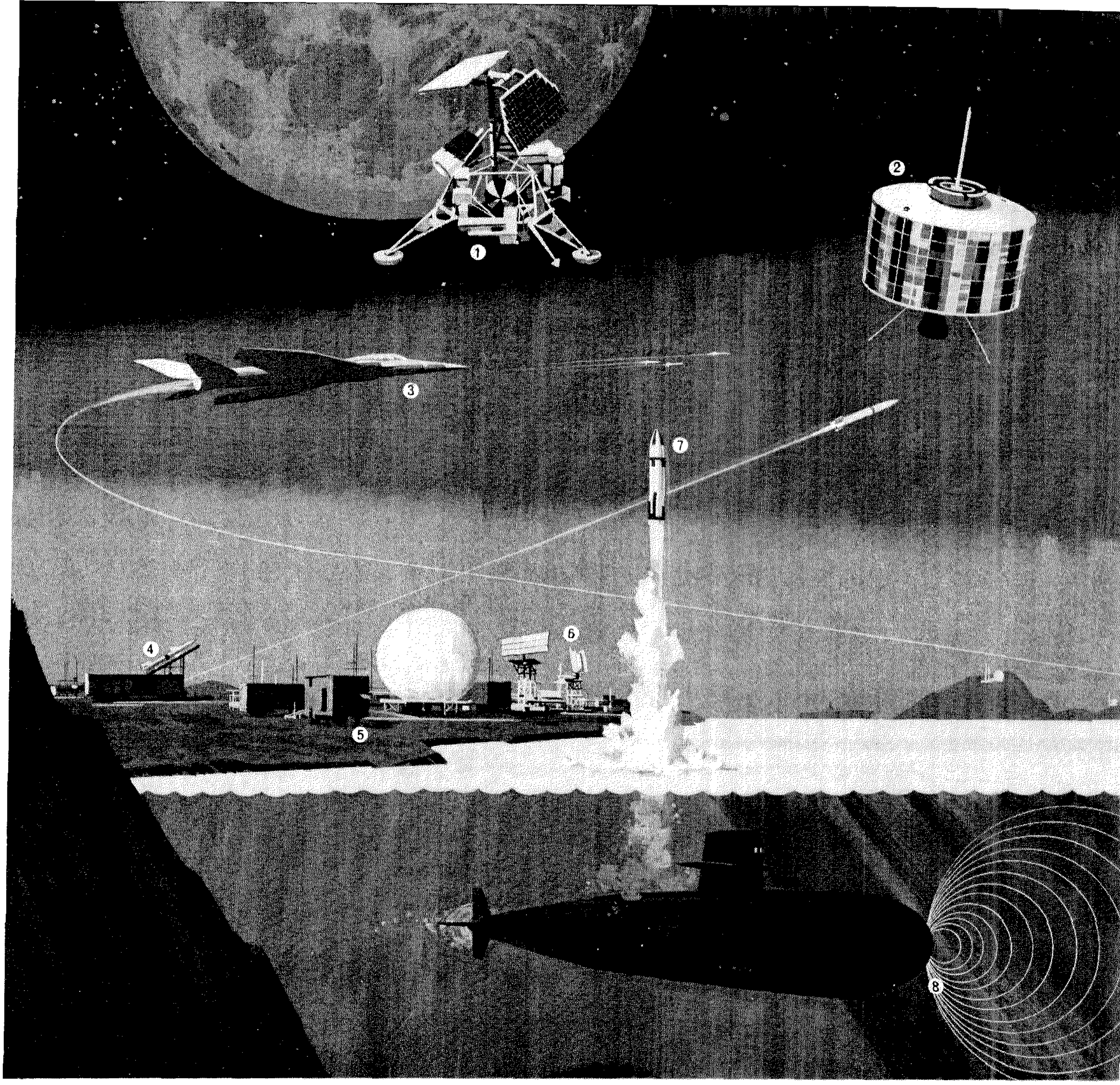

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ENGINEERING AND SCIENCE

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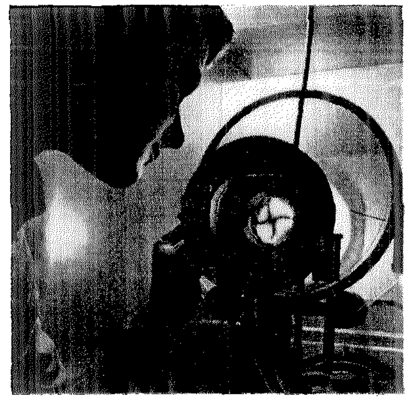


On Our Cover

Technician Heinrich Gebhard changes the stress field in a piece of viscoelastic material in Caltech's Graduate Aeronautical Laboratories. The study is being done in conjunction with work on the optical characterization of these materials now under way at Caltech and described in "Fracture Mechanics and Polymers" on page 10.

Photosynthesis and Growth

Henry Hellmers, plant physiologist with the Pacific Southwest Forest and Range Experimental Station of the U.S. Forest Service, and senior research fellow in biology at Caltech, has been here since 1949, working on a cooperative program of the Institute and the Forest Service to improve sparse plant cover on critical areas in the San Gabriel mountains. On page 12 – some news about his current research.

Caltech: Phi Beta Football

It's not *every* day that somebody takes a look at Caltech football from the outside – but that's what freelance writer Joseph N. Bell did in the October issue of *Cavalier*. What he saw was so refreshing that we offer a condensed version of his original article on page 22. Our thanks to *Cavalier* for permission to reprint.

Books

Mathematical Methods of Physics

by Jon Mathews and R. L. Walker

W. A. Benjamin, Inc. *$12.50*

Reviewed by Charles H. Papas, professor of electrical engineering

This book is a delightful exposition on the mathematical methods of physics. It is written in a charmingly informal style and covers a remarkably large number of topics. Throughout the text, carefully selected examples are worked out in detail to illustrate the principal points of the subject, and at the end of each chapter an abundance of original problems is provided to test and train the reader.

As is evident from the approach the authors have used, the main purpose of the book is a pedagogical one – to teach physics students how to use the mathematical tools of physics. It is this reviewer's opinion that the authors have succeeded admirably in writing a book that not only meets the didactic needs of the first-year graduate student, but also satisfies the practicing physicist who for some time has been hungry for a readable book on mathematical methods written for physicists by physicists.

Although there are other books on the subject, none of them seems to come as close to the mark as this one does. They are either too mathematical in the sense that they are preoccupied with questions of uniqueness, existence, and pathological behavior, or they are overly detailed and hence too unwieldy to cover in a one-year course. What makes this book stand out for the physicist is the fact that it covers so much so well, and does it all in the lively jargon of mathematical physics.

Some idea of the scope of the book can be got by examining the following list of chapter headings: Ordinary Differential Equations; Infinite Series; Evaluation of Integrals; Integral Transforms; Further Applications of Complex Variables; Vectors and Matrices; Special Functions; Partial Differential Equations; Eigenfunctions, Eigenvalues and Green's Functions; Perturbation Theory; Integral Equations; Calculus of Variations; Numerical Methods; Probability and Statistics; Tensor Analysis and Differential Geometry; Introduction to Groups and Group Representations. Clearly, the scope of the book is very broad and includes most of the useful mathematical methods of modern physics. To present all this material in a book that has less than 500 pages and to do so with sufficient depth to satisfy the practical needs of the physicist is an enviable achievement.

I offer my congratulations to the authors – Jon Mathews, associate professor of theoretical physics; and R. L. Walker, professor of physics at Caltech.

I recommend this outstanding book not only to physicists but also to electrical engineers whose bread and butter all too often depends on how well they can calculate.

Quantitative Chemistry (Revised Edition)

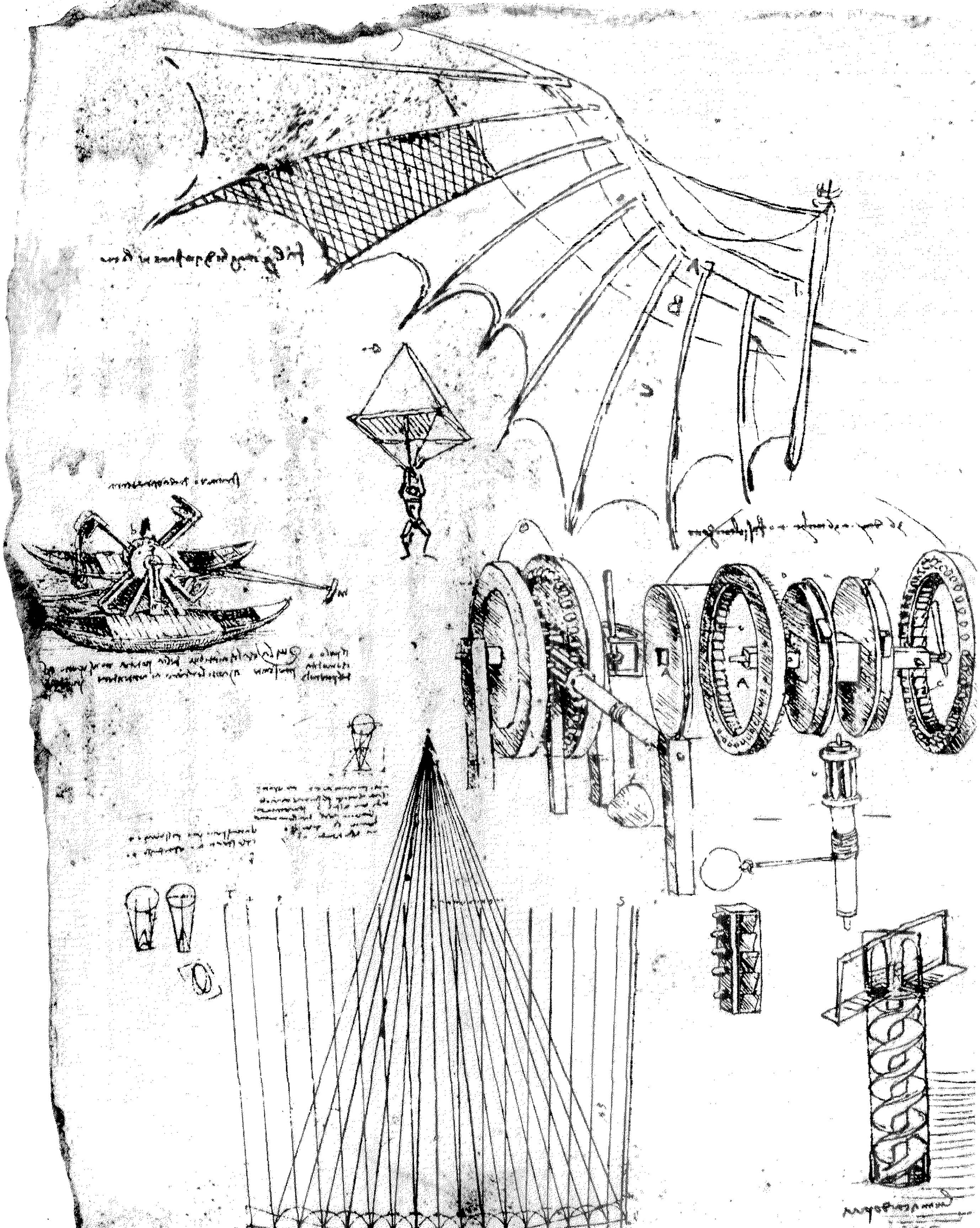
by Jurg Waser

W. A. Benjamin, Inc..........*Paper $3.95, Cloth $6*

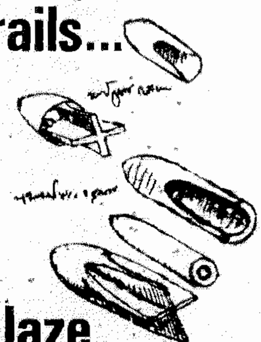
Reviewed by W. P. Schaefer, assistant professor of chemistry

The revised edition of this book puts between hard covers the laboratory manual used by freshman chemistry students at Caltech for the past six years. The preliminary edition of the text was issued in 1961 for use in fresh-

continued on page 8



Leonardo da Vinci blazed many new trails...



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man laboratory work in the new chemistry program (new, that is, in 1957). The new program revised many of the established courses of the division, but the biggest change was in the laboratory part of the freshman course. All of the material formerly covered in the first part of the year – simple inorganic preparations and semiquantitative "tests" of elementary chemical principles – was replaced by the traditional work of the sophomore year, i.e., quantitative analysis. No textbook was available for a quantitative analysis course at the freshman level; Dr. Waser (who is professor of chemistry at Caltech) has remedied this lack.

Since the book was written for a specific freshman course, it should be evaluated in terms of its intended use. Preliminary instructions and directions for weighing are unusually complete; no presumption is made that the student will be familiar with laboratory work. Each assignment which follows consists of a thorough, detailed description of the principles underlying the experiment, and a briefer section containing specific directions. The theoretical sections for the experiments represent the major difference between this book and conventional introductory analytical texts; they are undoubtedly its greatest strength. The essential chemistry and calculations are explained in depth here and an effort has been made to cover every detail. No apologies are made for rigorous, accurate descriptions; Caltech students appreciate not being talked-down-to.

The freshman course was designed to introduce the students to as many different kinds of quantitative measurements made on chemical systems as possible and the assignments in the text reflect this decision. They include one gravimetric, one colorimetric, one gasometric, one coulometric, and seven volumetric determinations, plus an example of the use of the method of "Continuous Variations" for finding the formula of a complex ion. The volumetric determinations cover acid-base, precipitation, complexometric, and oxidation-reduction titrations; thus most of the techniques of analytical chemistry are presented, but with at most two examples. Teachers in conventional courses, still (subconsciously?) training chemical analysts, may object to the absence of repetition but the coverage seems just right for the freshman course at the Institute, where even the mathematicians must now learn to read a buret accurately.

The book is well set-out and adequately illustrated; in its paperback version, it is remarkably low-priced for a college textbook. As a rigorous introduction to chemical measurements, *Quantitative Chemistry* is probably the best book presently available. It is a pleasure to teach from such a text.

Ancient Ruins and Archaeology

By L. Sprague de Camp and Catherine C. de Camp

Doubleday $5.95

The prolific L. Sprague de Camp '30 (who has now written more than 40 books) has collaborated with his wife on this lively volume dealing with 12 famous mysteries of the ancient world – including the lost continent of Atlantis, the pyramids, Stonehenge, Troy and Mycenae, King Solomon's mines, King Arthur's court, Angkor Wat, and Easter Island. The De Camps write about these ancient ruins and riddles with spirit and vigor, as well as with scientific accuracy.

ENGINEERING
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January 1965, Vol. XXVIII, No. 4

FRACTURE MECHANICS AND POLYMERS

There is great incentive to study the fracture behavior of polymers because the findings are potentially applicable to a large class of other materials

The study of fracture mechanics is concerned with the fundamental aspects of fracture – with such basic questions, for example, as: What are the parameters that influence fracture?

Materials used for these studies may range all the way from metals, to polymers like rubber and plastics, fiberglass laminates, and even rocks.

In the past five years there has been a concerted effort at Caltech to study the fracture mechanics of polymers – first, because there is little information available on the strength properties of these materials; secondly, because they have a direct relation to the fracture of solid propellant rocket fuels. Solid propellants are compounds made up of about 25 percent rubber, with the remaining 75 percent consisting of oxidizer (such as ammonium perchlorate) and some metallic additives.

Because researchers at Caltech cannot work with explosives, they have chosen to use pure polymers for their studies. These materials have many of the basic properties of other viscoelastic materials such as solid propellants and airplane or automobile tires. The basic difference between polymers and metals at ordinary temperatures is that polymers have time-dependent properties, while metals have essentially static properties. However, when metals are heated to elevated temperatures, they may react in much the same way as do many polymeric compounds in their mechanical response, and they begin to flow and undergo large deformations under load.

Polymers can be viewed as a group of materials that form the transition between rigid materials and liquids. There is, therefore, great incentive to study the fracture behavior of these materials, because the findings are potentially applicable to a large class of other materials.

A special characteristic of viscoelastic fracture is that the material properties change while fracture occurs. Also, the material properties depend on the *rate* of fracture progression. This is generally not true in the case of metals.

Two major problems had to be faced when work was started at Caltech on fracture studies of polymers: (1) There was a lack of knowledge of the mechanical properties of these materials; (2) The materials that were available from industry were generally not uniform enough for use in a careful research program. During the past four years, therefore, considerable effort has been devoted to the material characterization, and to the mathematics to incorporate these material properties in engineering stress calculations.

Research in the field of fracture mechanics in Caltech's Graduate Aeronautical Laboratories is scarcely more than ten years old, but one indication

Wolfgang Knauss, research fellow in aeronautics, uses a sheet-straining device to measure the amount of energy that is dissipated when a fracture occurs in polymeric material.

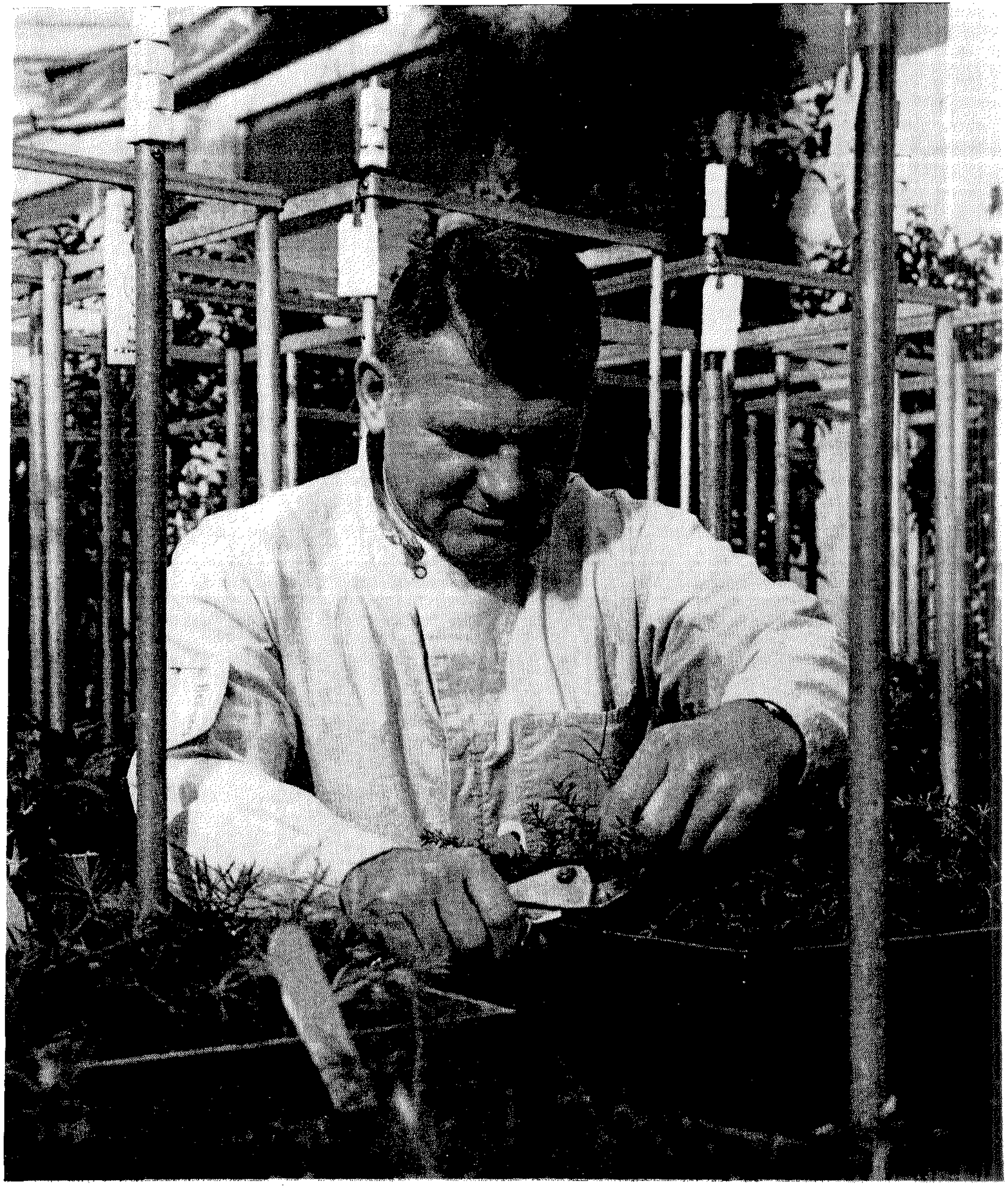
of the state of its health is the fact that it keeps spawning subsidiary research efforts. Thus, during the past year, the GALCIT work on the basic material parameters of polymers has resulted in a new field of study being set up in Caltech's W. M. Keck Laboratory of Engineering Materials – polymer science.

This endeavor has as its main purpose the investigation of the physical behavior of polymers from the molecular viewpoint. As part of the study, researchers are now trying to select or develop a polymer for standardization purposes.

While there are many groups working in this area of polymer research, both here and abroad, all of them are using different materials, so that comparisons of results are difficult to make. If all groups could be encouraged to use the same material, this problem would be simplified. The Caltech researchers are therefore interested in standardizing this material, and making it available from a central source, for use by industry and other research laboratories.

One of the possibilities for such a material is a polyurethene polymer, compounded with castor oil, which is clear, permitting easy observation of fracture-initiation and growth. Because it is also stress-optically very sensitive, it permits the experimental determination of structures which are hard to analyze theoretically. Thus, it is useful in the study of fracture mechanics, where complex geometrics occur. The stress-optic fringe pattern in the picture above, for example, can be used to determine the stresses at the tip of an advancing crack. Finally, and most important, the material behaves visco-elastically like solid propellants when at 0° C.

The Caltech research on fracture mechanics of polymers is under the direction of Max L. Williams Jr., professor of aeronautics. The polymer fracture research is guided by W. G. Knauss, research fellow in aeronautics, and is supported by the National Aeronautics and Space Administration. A grant from Edwards Air Force Base, California, is making possible the development of the Keck materials science program.



Henry Hellmers, senior research fellow in biology, trims a dwarf stand of coniferous trees to force them to form a dense canopy. These stands are used in measuring light and its effect on photosynthesis in a forest.

PHOTOSYNTHESIS AND GROWTH

Why aren't plants more efficient photosynthesizers? Caltech researchers are looking for the answers.

The National Science Foundation this month granted $83,000 to Caltech to continue for three years a broad investigation of photosynthesis – the process by which plants use the sun's energy to make plant material.

The results of this research, being carried out by James Bonner, professor of biology, and Henry Hellmers, senior research fellow in biology, could be useful in selecting the most suitable trees for replanting timbered and fire-ravaged forests, and also for revegetating watersheds.

The biologists are working with ponderosa pine and Douglas fir in Caltech's climate-controlled plant physiology laboratories. The study is aimed at determining the relative importance of temperature, light intensity, and carbon-dioxide concentration to photosynthesis.

The researchers already have determined the effects of low night temperature on photosynthesis. The cooler the night, the lower the subsequent rate of photosynthesis and the longer the time required for the tree to resume its normal manufacturing processes.

Photosynthesis in the late fall and winter largely produces food that is stored in the tree for use in the burst of new growth in spring.

Why aren't plants more efficient photosynthesizers? Why is it that wild forest trees appear to be more efficient users of the sun's energy than are pampered crop plants? These are some of the questions the Caltech scientists are hoping to answer.

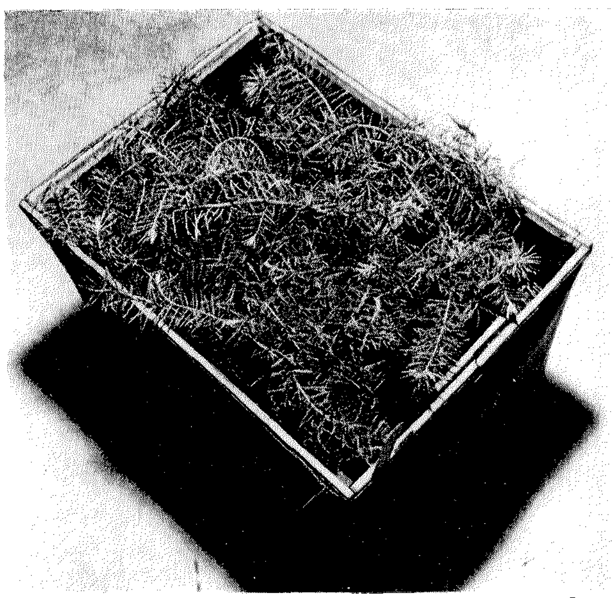
Forest trees make use of only about 2-1/2 percent of the sunlight that reaches them – but this is still 20 percent more than many domesticated plants and trees use. Why?

Dr. Hellmers, who is assigned by the U.S. Forest Service to Caltech, has developed an explanation for this puzzle.

The photosynthetic mechanism of agricultural plants and trees is the same. The differences between the two vegetation types must be in quantities of photosynthetic material or in some factor of the environment.

Communities of trees in a forest arrange their upper branches so as to form a canopy of leaves some five layers deep that covers them like a huge, green umbrella.

This living roof tends to concentrate beneath it one of the vital raw materials of all plants – carbon dioxide. Curtail this gas and a plant's photosynthesizing machinery slows down. Give it plenty of gas, and the machinery accelerates.



This section of a forest is growing in controlled light in Caltech's plant physiology laboratories. The container allows only about 5 percent side light to reach the trees, resulting in a dense layer of growth in the upper portion of the canopy.

Research assistant Eddy Schuurmans shows the density of the crown of the miniature forest, and the self-pruned lower portion of the trees.

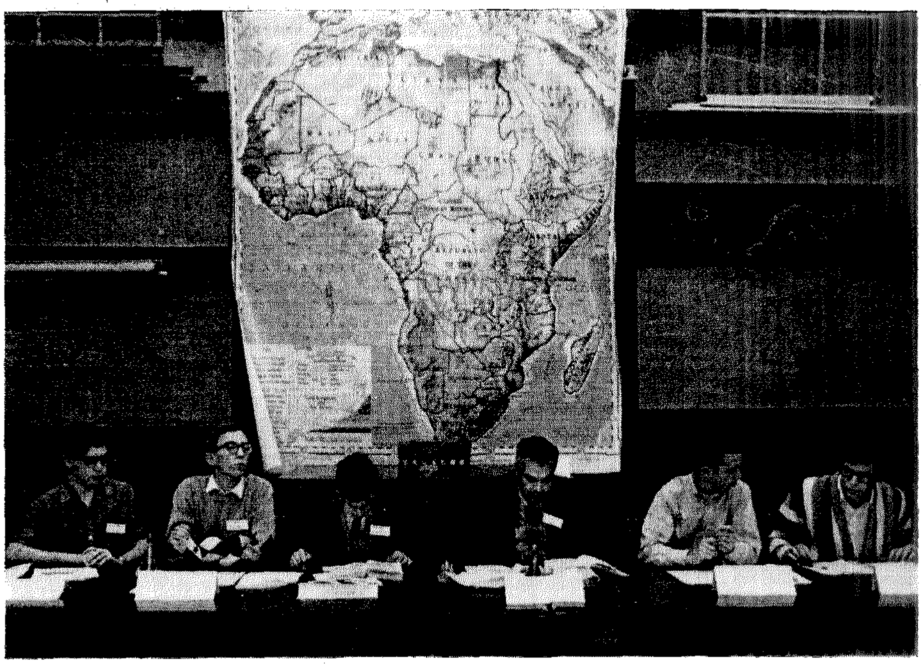
Carbon dioxide is given off by the plants themselves, as well as by all living creatures, as a waste product of metabolism. It even comes up from the ground, given off by creatures living in the ground.

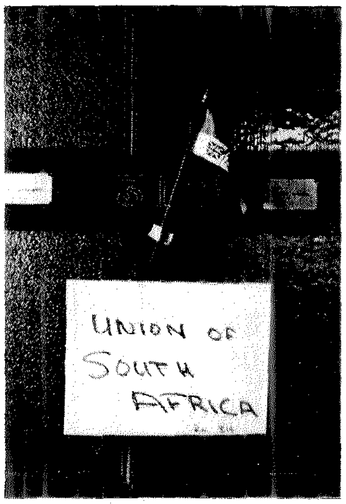
At night, when the photosynthesizing factories are shut down (the moon and stars do not provide enough light to operate this mechanism), the carbon-dioxide content of the air builds up. The forest canopy reduces air movement and thus prevents the gas from escaping. Crop plants behave similarly but, being shorter than trees, they entrap a smaller volume of air and therefore less carbon dioxide.

With the coming of dawn, light triggers photosynthesis. The built-up reserve of carbon dioxide under the forest canopy increases the rate of photosynthesis and the formation of plant material.

Dr. Hellmers now is testing his theory in the Caltech plant physiology laboratories, where climate, temperature, and light can be rigidly controlled.

Could the production of orchard trees be increased by allowing them to develop a closed canopy? Dr. Hellmers doesn't think so. He points out that an orchard with a closed canopy would probably cause more height growth and would put virtually all of the fruit near the top of the trees. This might be more of a boon to birds than to people.





INTERNATIONAL CRISIS ON CAMPUS

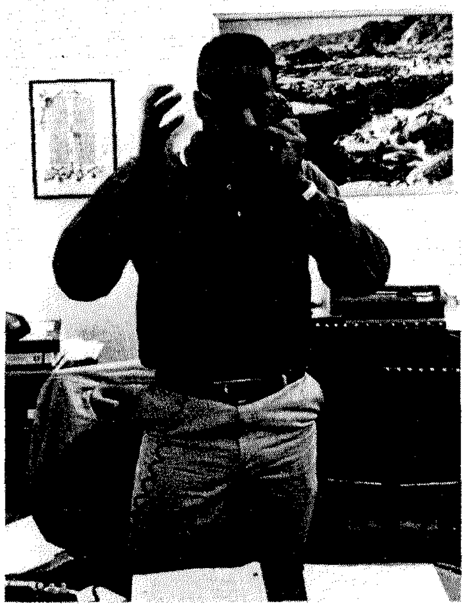
The most unfortunate thing about being a foreign affairs specialist is that it isn't possible to experiment with countries the way a biologist can with monkeys. To alleviate this problem, shortly after World War II, the RAND Corporation worked out some political-military games, using groups of people to play the roles of the various governments involved in an artificial crisis. This month Caltech set up one of the games, as an educational experiment, involving groups of students and faculty in a crisis in Southern Rhodesia.

Groups were formed ahead of time to play the roles of the U.S., the U.S.S.R., the United Kingdom, Rhodesia, the Union of South Africa, the moderate African states (Zambia, Tanzania, Uganda, Kenya, and Nigeria), and the militant African states (U.A.R., Ghana, Guinea, Algeria, and Morocco). The participants put in a lot of intensive study on the military, economic, and political characteristics of their respective countries to provide a realistic basis for game actions.

In addition to the national groups, there was a control board to pass on the credibility of all messages before delivery and to keep track of the game's general progress; observers, sitting in with each national group; and messengers, to handle communications.

At 8:30 a.m. on January 9, the cast assembled and was presented with a scenario of the initial crisis — an outbreak of violence between whites and blacks in Rhodesia with assorted assassination attempts, raids (from Zambia), a flight of rural farmers to Mozambique and South Africa, and other troubles. After reading the scenario, all groups went to their offices to start the actual play. The play was divided into five periods of about three hours duration. At these times the members of the national groups stayed strictly in their rooms to avoid any inadvertent passage of information to another group.

Actual play consisted of sending messages to other groups, and to the control board. To provide a complete record of the game, all messages were in triplicate and one copy was retained by the sender, one by the receiver, and one by the control board. The control board kept the action going by formu-



lating press releases for general distribution, engineering security leaks, and producing additional scenarios between play periods. A few U.N. meetings, presided over by U Thant (David Smith, assistant professor of English), were held between the foreign ministers of the groups. These meetings were broadcast to all parties through a P.A. system.

Contrary to all expectations, the troubles in Rhodesia settled down quickly, since the moderate African group avoided a direct confrontation of Rhodesian military strength and chose instead to invade Mozambique.

This unexpected turn of events illustrates the unpredictability of the game. Even when all the background is known, the actual course of events often follows some path that hadn't been thought of previously. Examination of variant developments of the same crisis, when played by different casts, sheds some light on the alternatives to what has actually happened in the world.

In the case of the Caltech game, the primary function was to learn, according to Dr. Edwin S. Munger, Caltech's African affairs specialist. Members of the national groups learned about their countries and the operation of international relations. Since they had been admonished not to blab to members of the other national groups during the game, their viewpoint was restricted until the game ended.

Since the game ran through both Saturday and Sunday, the action slowed down for some groups. This resulted in the production of poems by South Africa, and at least one message reading, "Are *you* bored?"

The messengers and observers, not being bound by a vow of silence, had a more general view of the game. They learned something about the things that are involved in international relations – most particularly (1) that there is an incredible amount of footwork involved in the delivery of diplomatic mail (one messenger's estimate was that he had walked 12 miles in the two days) and (2) that a shortage of typists is hell on international relations.

—Rodger F. Whitlock '65

The Month at Caltech

AUFS on Campus

The first of four representatives of the American Universities Field Staff arrived on campus January 5 to report on political, social, and economic conditions in foreign areas. James W. Rowe, authority on Argentina and Brazil, was at Caltech from January 5 to 14. As a Fellow of the Institute of Current World Affairs, Mr. Rowe lived in these two largest South American republics from 1961 to 1963. Before that time he was on the staff of the Governmental Affairs Institute in Washington, and was an assistant to U.S. Senator Russell Long of Louisiana.

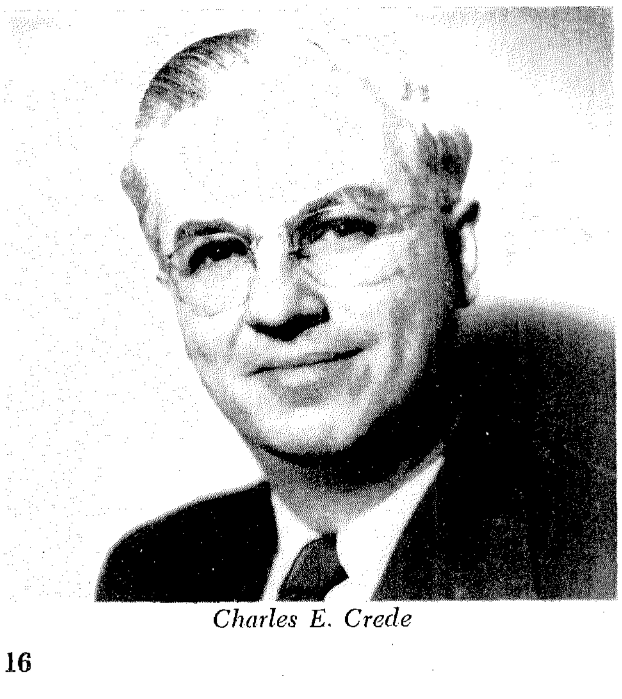
Edward A. Bayne, writer and political observer, will be here from January 19 to 28 to report on affairs in Italy, Iran, Israel, and Somalia. He is making his fifth visit to Caltech since he became an AUFS Associate in 1953. His book *Four Ways of Politics* will be published this year by the AUFS.

Charles F. Gallagher, whose field of study is the Arab world, will make his fourth visit to the campus under AUFS auspices, from February 2 to 11. Gallagher began his Arab studies in 1951, and did graduate work in Paris and North Africa under Ford and Fulbright fellowships, specializing in North African history.

Dennison I. Rusinow, last of the four AUFS lecturers on this year's program, reports on Yugoslavia from February 23 to March 4. Rusinow has spent 14 years of study on Adriatic Europe, with a specialty in the problems of Hapsburg Successor States.

The AUFS was organized in 1951 by a group of American colleges and universities, including Caltech, to send qualified young men to specific foreign areas to study and report on current conditions.

The men, chosen for their skill in collecting, reporting, and evaluating data, combine personal observations with scholarly studies relating to their areas. They spend long periods of time abroad and return every two years to lecture on the campuses of the sponsoring institutions.



Charles E. Crede

Charles E. Crede

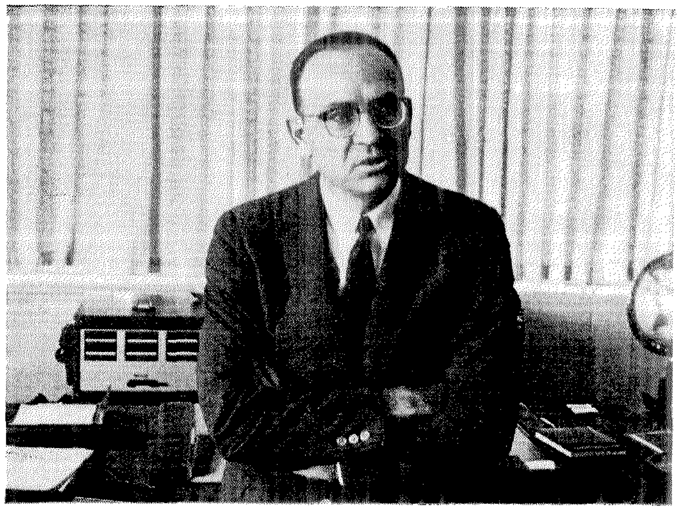
Charles E. Crede, 51, professor of mechanical engineering and applied mechanics at Caltech, died on December 29, 1964, after a long illness.

Professor Crede received his BS degree from the Carnegie Institute of Technology in 1935. He attended the graduate school of the Massachusetts Institute of Technology as a Tau Beta Pi Fellow, receiving an MS degree in 1936. After a period of industrial engineering work in railway equipment design, he became a civilian engineer with the Navy Department Bureau of Ships in Washington, D.C. There he developed quickly into the leading expert in the means of protecting shipborne equipment from the severe shocks encountered in naval warfare. In 1944 he transferred to the Naval Research Laboratory to organize and direct the first Shock and Vibration Division there.

At the conclusion of World War II, he became

continued on page 20

"The development of management is essential to our goal of great growth"



At the 1964 stockholders' meeting, Arjay Miller, President of Ford Motor Company, emphasized the Company's far-sighted recruitment program and its accent on developing management talent:

"One aspect of our planning is crucial to the success of everything else we do. It engages the best thoughts and efforts of our whole management team, from top to bottom, throughout the world. I am speaking of the development of management. The immediate future of our Company depends heavily upon the abilities of the people who are now key members of our management team.

"In the longer run, our future depends on what we are doing at the present time to attract and develop the people who will be making the major decisions 10 to 20 years from now. We are developing management competence in depth in order to attack the problems that will confront a company of great growth—and great growth (both in profits and sales) is exactly the goal we have established for Ford Motor Company.

"We are continuing to emphasize recruiting. Last spring, 180 of our management people devoted part of their time to recruiting outstanding graduates from colleges and universities throughout the U.S. Last year, these efforts resulted in our hiring over 1,000 graduates, 220 more than the year before.

"We are seeking and we are finding young men—and young women, too—with brains and backbone—people who have the ability and the desire to make room for themselves at the top. We give our trainees challenging assignments with as much responsibility as they can carry. We promote them as fast as they are ready. Those who are interested in easy security soon drop out. Those who have what we want stay with us, and move up quickly to increased responsibility and the pay that goes with it. Thanks to the quality of the people we are recruiting and developing, I am firmly convinced that our outlook is most promising."

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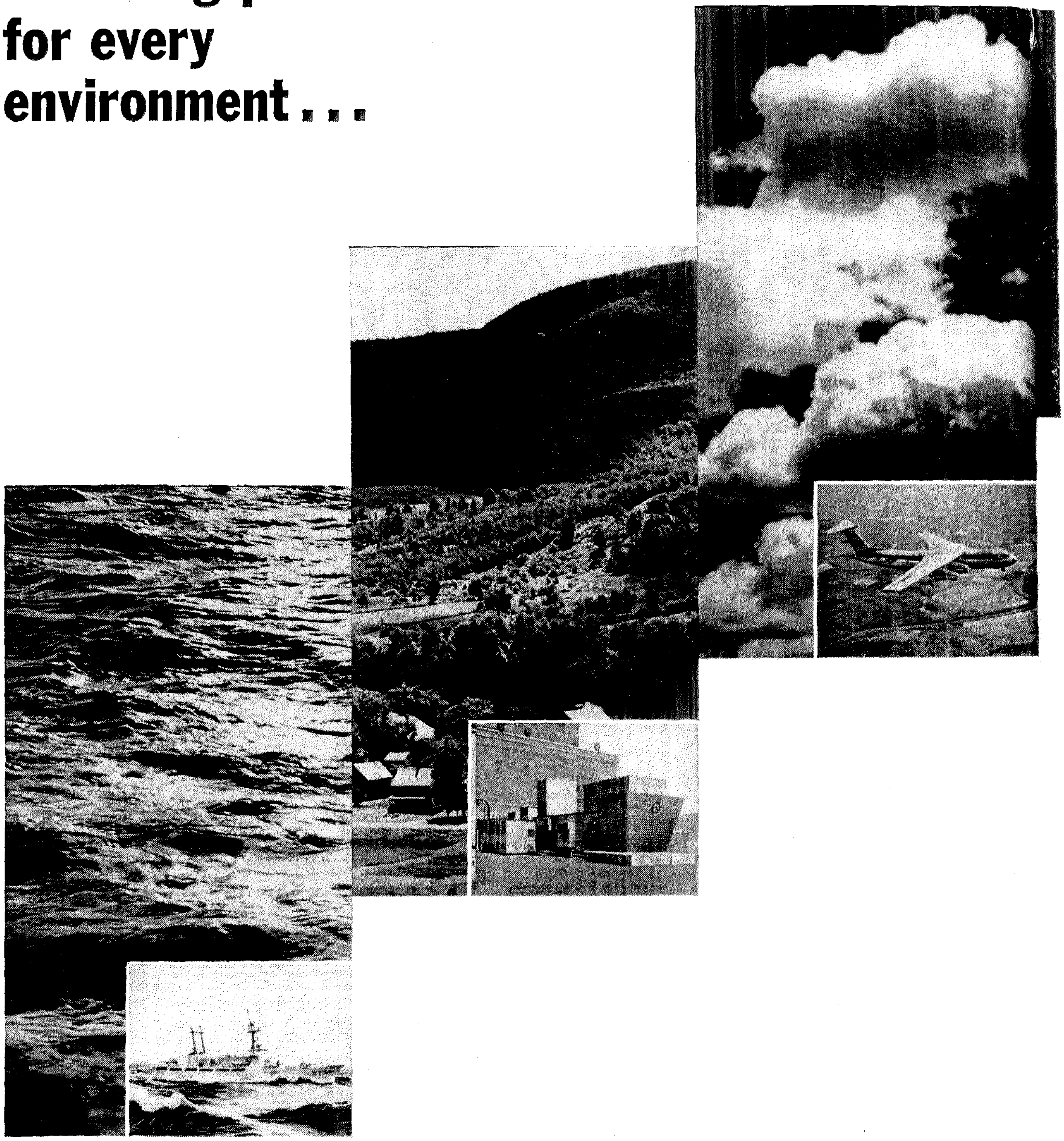

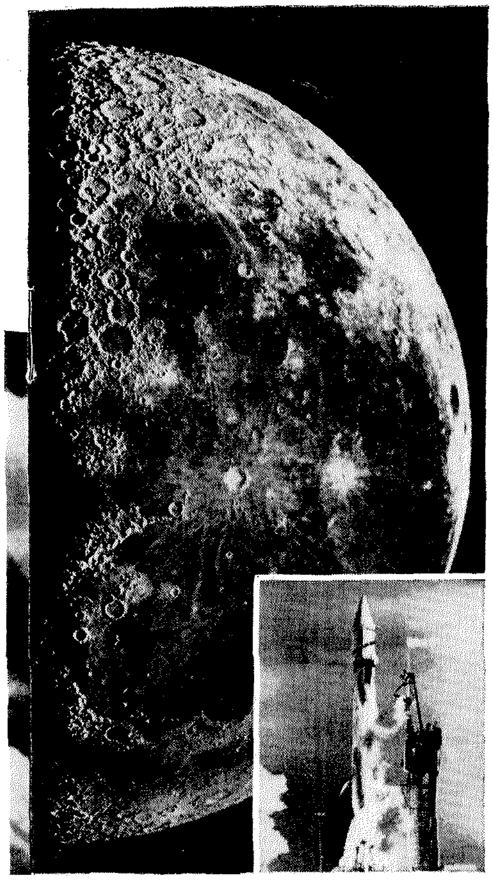

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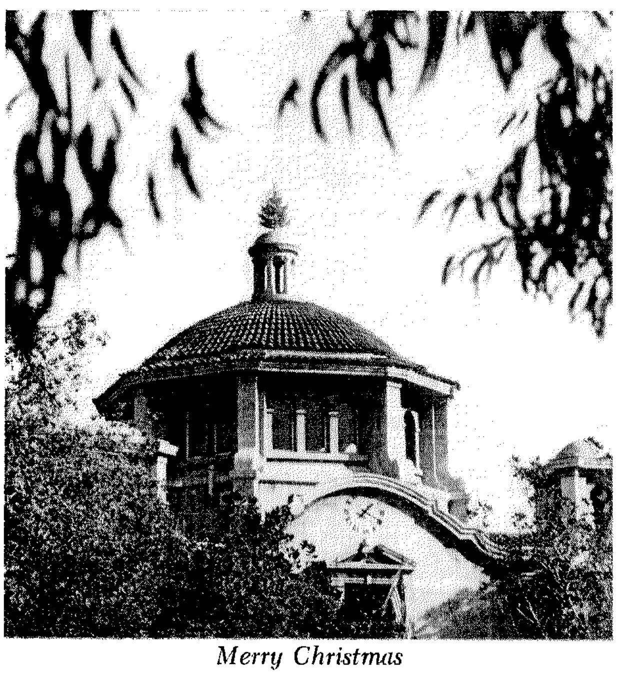
vice president of Barry Controls, Incorporated, in Watertown, Massachusetts, in charge of all research and engineering. He joined the Caltech staff in 1958 and rapidly assumed an active role in all aspects of Institute life. He was a much-sought-after engineering consultant for many governmental and industrial activities, being a key figure in Air Force design studies for underground missile launching sites and for NASA investigations of shock and vibration problems in rockets.

Professor Crede was a Fellow of the American Society of Mechanical Engineers, and of the Acoustical Society of America, and a member of numerous other societies. He was a national vice president of the ASME, and in 1959 received the first ASME Machine Design Award for eminent achievement in shock and vibration technology. In 1957 he gave the annual invited Murray Lecture to the Society for Experimental Stress Analysis. He played an important role in the activities of the American Standards Association as chairman of numerous committees.

As the author of many technical papers he had a wide influence on all aspects of shock and vibration technology. His book *Vibration and Shock Isolation* has been, since it appeared in 1951, the international standard reference in the field. In 1961 he was co-editor with Professor C. M. Harris of Columbia University of a three-volume *Shock and Vibration Handbook* which stands as the main authoritative source of information for the field.



Merry Christmas

In addition to his professional interests, Professor Crede contributed to many Caltech administrative and educational committees. As chairman of the Athenaeum House Committee for several years, he devoted himself with unusual energy and success to the continued development of the Athenaeum.

Professor Crede is survived by his wife; his son, Donald; and two daughters, Barbara and Eileen.

Edith Maynard Wallace

Miss Edith Maynard Wallace, scientific illustrator for Thomas Hunt Morgan, died on December 20 in Pasadena. Her drawings of Drosophila, the small fly used extensively in genetic research, have never been equalled for accuracy or for artistic merit. Done both in color and black and white, the drawings have been studied and admired by all geneticists for over 50 years.

Miss Wallace was born in Boston. Her early years were spent in Nashua, New Hampshire, where her father, Alonzo Wallace, was a well-known physician and surgeon. She was graduated from Mt. Holyoke College in 1903, and after taking an MA at Clark University taught biology at Western College for Women in Oxford, Ohio, and later at the University of Maine. In 1908 she gave up teaching and became scientific artist for Professor Morgan, then at Columbia University. She came to Pasadena in 1928 when Professor Morgan transferred to Caltech to start the division of biology. She continued to live in Pasadena after her retirement in 1944.

A brother, Dr. Arthur Wallace, and a sister, Mrs. Ralph H. Norris, both living in New Hampshire, survive her.

Christmas Present

Caltech undergraduates gave the Institute an early Christmas present this year when, during exam week in mid-December, they installed a decorated tree on the top of the Throop Hall dome.

Whether it was a calculated engineering triumph, or just an exercise of courage and stamina on the part of the anonymous students who contributed the decoration, was not important. The fact remains that the tree continued to provide holiday cheer right through the season. Twice it was toppled by strong winds in the night, and twice it was set straight again by morning. And, long after the students went home for the holidays – and even after the holidays were past – its colored lights went on every night without fail.

CALTECH: PHI BETA FOOTBALL

A condensation of an article which appeared in Cavalier Magazine for October 1964

by Joseph N. Bell

In the smog-sodden gloom of a late November afternoon last fall, the football team of the California Institute of Technology took it on the chin from Harvey Mudd College of Pomona by a score of 39-0. No one was too surprised at the result. Caltech had won only one game all season, and—in its league—Harvey Mudd was reputed to have a strong team. There were, however, some other things about this game that were quite unique to college football.

The game was originally scheduled for Friday night, November 22, in the Rose Bowl. Although Caltech had booked the Bowl many months ahead for this game, a local high school found itself unexpectedly in the finals of a regional tournament to be decided the same night. Considerable pressure was exerted on Caltech to give up the Rose Bowl to the high school, but the Caltech athletic department was adamant. "Our seniors," said one of the coaches, "want to play their last game in the Rose Bowl . . . God knows, at least they deserve *that*."

As it turned out, no football was played on that Friday night, anywhere. The President of the United States was assassinated that day.

Caltech rescheduled its game with Harvey Mudd for the following Tuesday afternoon, and it was played in almost complete secrecy. This was nothing new for Caltech teams, however. Almost everything in the way of intercollegiate athletics at Caltech is done in secrecy.

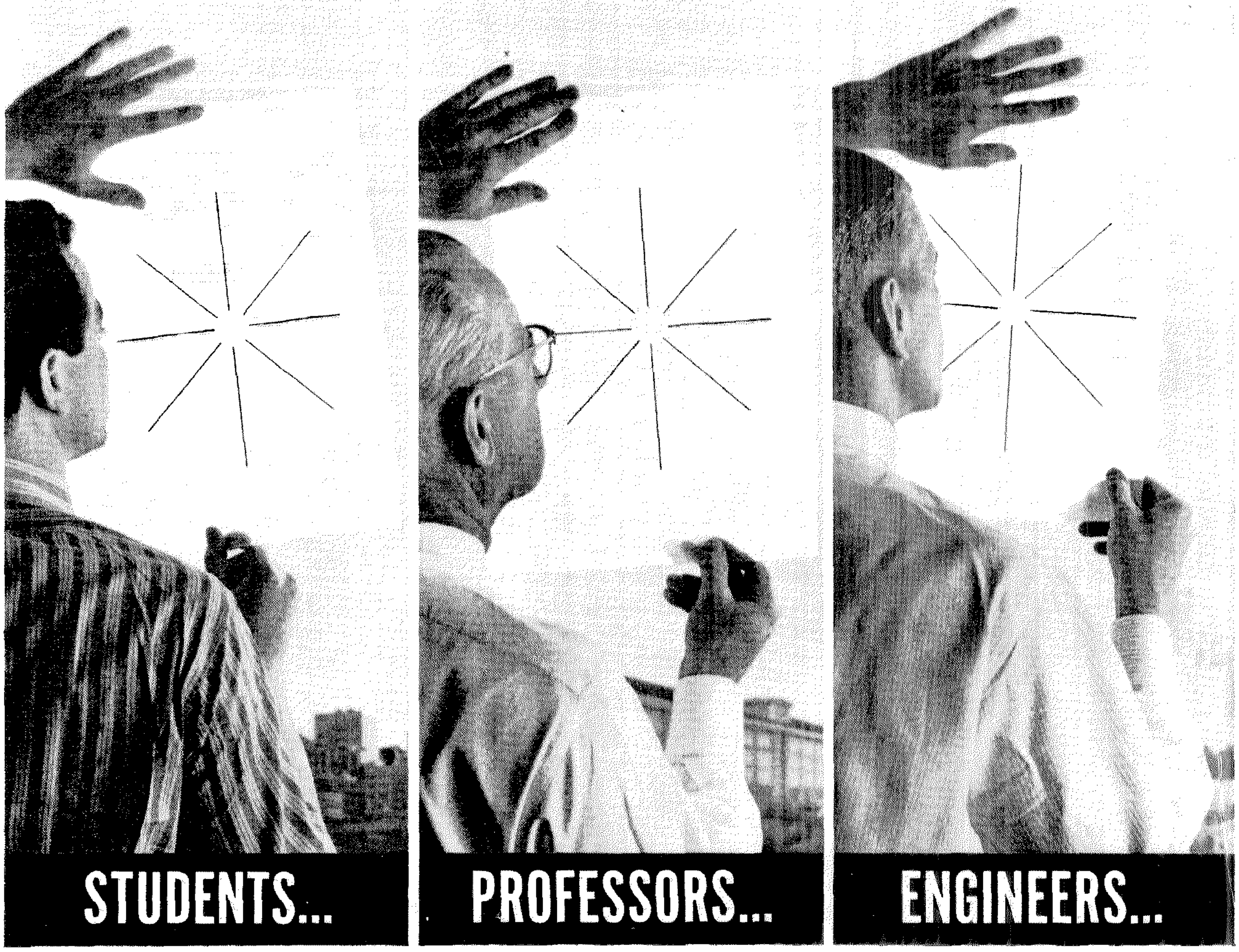
Running an intercollegiate athletic program at a school like Caltech poses some strange and wonderful problems. For example, there was a considerable crisis on the football practice field late in the season last year when a halfback lost a contact lens during scrimmage.

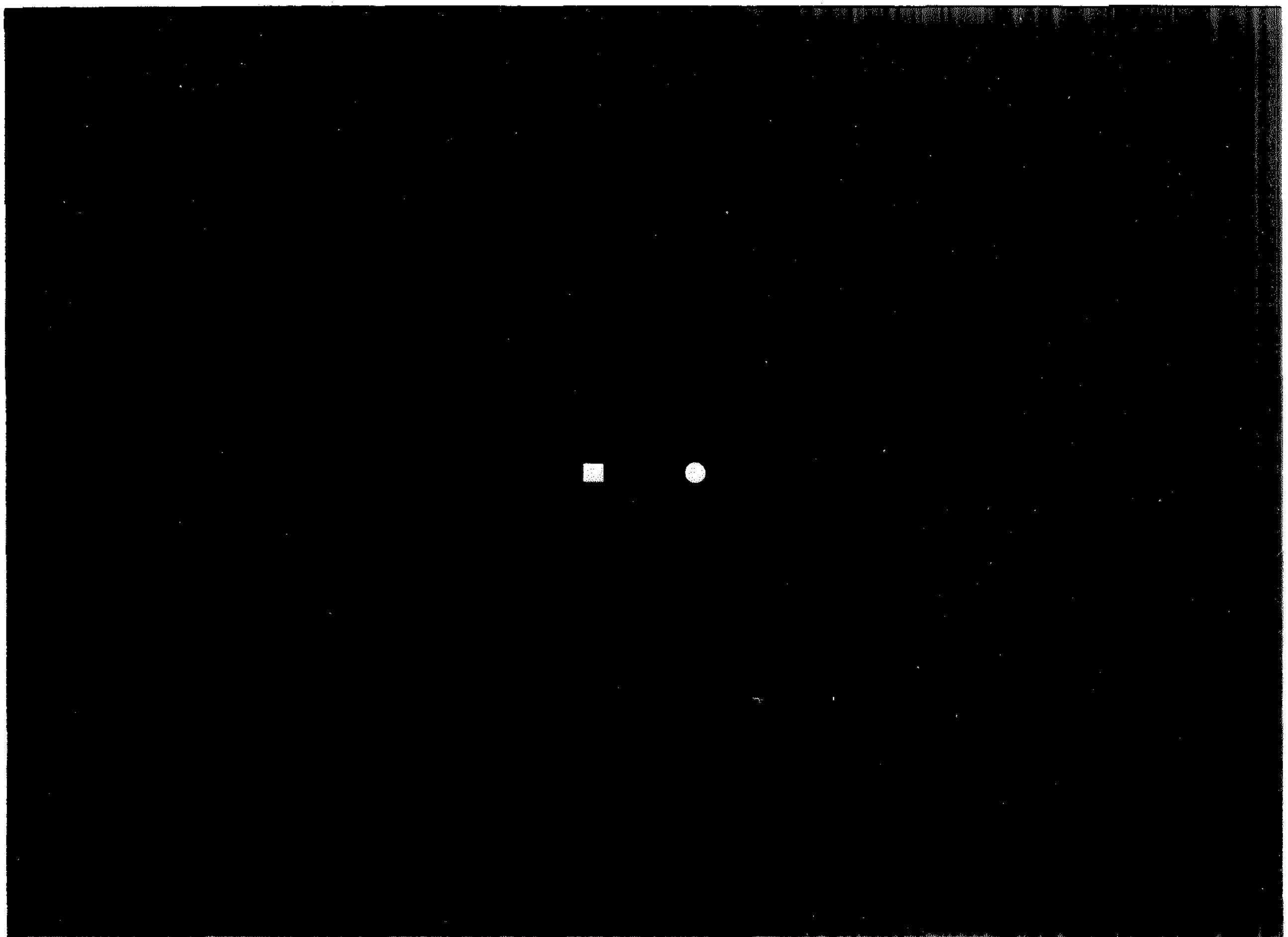
Contact lenses are a continuing and exacerbating problem in Caltech football. An uncommon number of Caltech players wear glasses since they spend an uncommon amount of time poring over books—admittedly an unusual avocation among the average run of college football players. Since no one has ever figured out how to play football while wearing a pair of glasses, the Caltech players have had to fall back on contact lenses, which persist in popping out at embarrassing moments. It has happened more than once during a game, and time has to be called while the players get down on their hands and knees and grope about the turf looking for the tiny piece of optical glass.

Perhaps a certain degree of melancholia can justifiably be permitted the Caltech football coach—particularly in view of his previous life in another world. His name is Bert LaBrucherie, and in 1946 the football team he was coaching at the University of California at Los Angeles completed an unbeaten season against topflight opposition and was selected to play in the Rose Bowl. On New Year's Day of 1947, Mr. LaBrucherie made a grievous error in judgment; he lost to the University of Illinois 45-14. Obviously, the alumni and the university administration could not put up with this sort of nonsense, and the following year they suggested to Coach LaBrucherie that his resignation would be gratefully accepted.

Coach LaBrucherie was understandably disenchanted with the coaching profession after this episode and he said the hell with it and sold automobiles for six months. He was approached by several big-name schools, but they were far away from his Los Angeles home, and he didn't want to leave California. Then, about the time he was discovering that a career in the automobile business wasn't going to satisfy his creative juices, he received, and accepted, a coaching offer close to home—from the California Institute of Technology.

Caltech has never been noted for its athletic program, although it does offer considerable assets in such other areas as science and engineering. There are those who consider it the finest school of its kind in the nation—better, even, than MIT. It has nurtured nine Nobel laureates and is probably the most difficult school in the country for an undergraduate to get into. Its list of accomplishments in the scien-


STUDENTS...
PROFESSORS...
ENGINEERS...



tific field are even longer than Ohio State's conquests in football.

Caltech does, however, insist on policies that are likely to give any red-blooded American coach pause. It doesn't, for example, offer any athletic scholarships, doesn't own a stadium, doesn't permit recruiting of athletes, offers no scholastic concessions to athletes, and demands with sticky insistence that athletes not only attend all their classes and labs but also keep their grades up in competition with some of the most profound young brains in the United States.

This puts certain restrictions on the activities of a football coach. Since athletes can't be proselytized and athletic prowess is of negligible importance in considering applications, Coach LaBrucherie has to work with the student body list handed him on registration day. It's enough to reduce any self-respecting football coach to tears. Inevitably, the list is replete with nearsighted 135-pounders.

Every year spawns new hope, however, that in this batch of intelligentsia may be an incipient All-American (or even, for God's sake, an All-Conference), and Coach LaBrucherie and his boss, Athletic Director Hal Musselman, scour the list and cull those who have indicated any sort of athletic tendencies—from carrying bats in Little League to running to the corner grocery.

Armed with these prospects (e.g., Schmitz, Siegfried, Iona, Ohio, 5′ 9″, 138 lbs, lettered in paddle tennis, jv in Indian wrestling), Coach LaBrucherie sets out on his recruiting program. His recruiting area consists of the college campus, his recruiting funds of a possible cup of coffee for the prospect paid out of his own pocket, and his recruiting arguments the healthy character-building benefits of intercollegiate athletics plus an opportunity to represent dear old Caltech before Linus Pauling, God, and the world.

Considering the intellectual attainments of the boys to whom these arguments are being presented, they understandably often turn out to be less than convincing. School spirit is a sometimes thing at Caltech. It is whispered that there are those who have attended Caltech clear through graduate school without ever getting around to seeing a football game.

As a result, Coach LaBrucherie has had to grapple with a whole new set of recruiting problems. "At UCLA," he recalls with pardonable nostalgia, "it was a privilege to be invited out for the team. Here I have to try and talk them into it."

"Nobody is ever cut from one of our athletic squads," interposed Mr. Musselman. "Nobody."

The problem, one gathers, is to get them to come out, and the athletic department's competition for the time and attention of athletically inclined students comes from remarkable directions.

Usually the excuse given is, "I haven't time to practice. It takes all my time to keep my grades up enough just to stay in school."

The rationality of this argument sometimes obscures its lack of validity. Caltech is tough, but it's not *that* tough for all of the students who could compete in sports. Sometimes academics is used as an excuse for more exotic reasons for not turning out for intercollegiate sports – such things, for example, as the disinclination to get beat, with deadly consistency; or a greater athletic loyalty to a dormitory team.

"When a man wins a varsity letter," observed Coach LaBrucherie moodily, "he's no longer eligible for intramural competition in that sport. So some of our boys who could make varsity teams are pretty careful to avoid making a letter."

A few years back, LaBrucherie spotted a 200-pound six-footer playing quarterback in one of the intramural games. To Coach LaBrucherie, he looked like Red Grange, Tom Harmon, and Sammy Baugh all rolled into one. He floated pass after pass 30 to 40 yards downfield, hitting his receivers with remarkable accuracy. At the time, Caltech had had to give up passing in its intercollegiate games because a frightful number of passes were being intercepted.

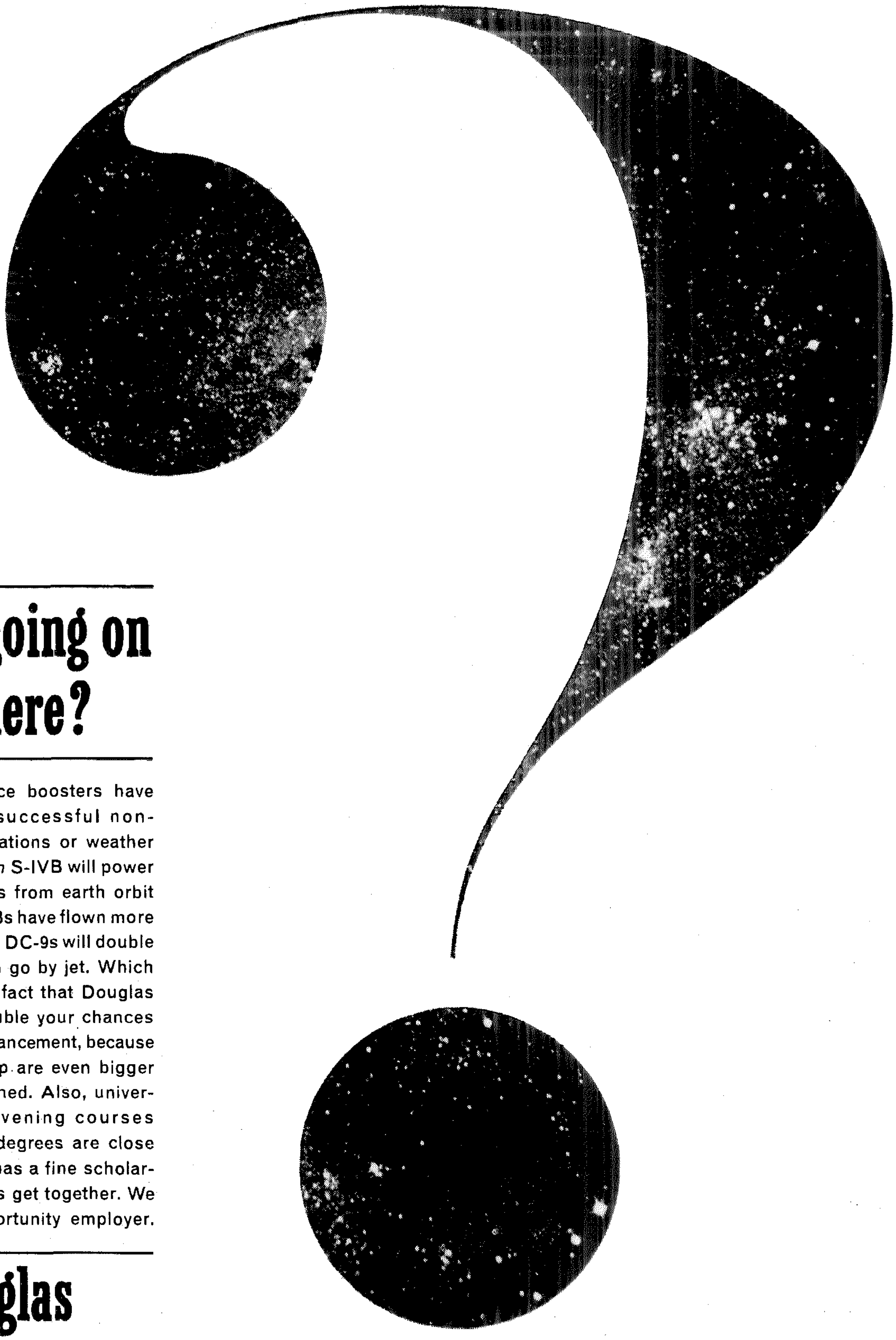
Eagerly LaBrucherie approached the boy and told him, "A fellow your size who throws a pass like that should be playing football."

"I *am* playing," said the boy, surprised at the coach's lack of perception. "I'm the quarterback for Dabney House."

"No," said LaBrucherie, "I mean for the *college* team."

The boy allowed as how he hadn't thought about that, and for a week LaBrucherie worked on him with every verbal trick he'd learned in a decade of big-time college coaching. At the same time, the dorm leaders were working to protect their investment. In the end, LaBrucherie lost, and the 200-pounder continued to throw his passes for the dorm team.

After fifteen years of this sort of thing, La Brucherie has become more or less accustomed to it. Not entirely; just more or less. There are compensations. Nobody, except the coaches and players who care *very* much, gives much of a damn whether Caltech



wins or loses. No students are hanging LaBrucherie in effigy, even after the team loses 25 in a row as it did over a span of several recent years. No alumni are bringing pressure on the school administration to fire him and bring in a winner. No sports writers second-guess him. And no enemy scouts try to spy on his practice sessions. Actually, the coach would be delighted if someone—anyone at all—would be enough interested to come out and watch football practice.

Few enough people turn out for the games, which makes for one of the more remarkable anachronisms in college football today. Caltech's football home is the Rose Bowl. The Rose Bowl is a Pasadena municipal stadium and Caltech, as a Pasadena resident, is entitled to rent it. Four Friday nights a season, the Caltech team takes its lumps in this massive concrete bowl, filled almost entirely with cavernous shadows and sepulchral silence. The capacity of the Rose Bowl is 100,000; Caltech games draw somewhere between 1,000 and 2,000 people, depending on the enthusiasm of the student body of the visiting team.

Superficially, it would seem that working with great intellects would be a welcome draught of cold water to a thirsty football coach, but there have been many introspective moments when LaBrucherie would gladly have traded the accumulated IQ of his entire team for one mean, muscular, thickheaded, revved-up linebacker.

It's a modest triumph for Coach LaBrucherie to diagram the most complex play for his men and see instant understanding instead of the vacuous bafflement of the typical Phys. Ed. major who is being frantically tutored so he can maintain a passing grade in bait casting and folk dancing. But, with LaBrucherie, the frustration comes with the execution rather than the comprehension.

"Sure these Caltech kids learn their assignments faster," points out the coach, "but that doesn't help much if they don't have the physical equipment or ability to execute them. A little experience might help, too."

Athletic experience is hard to come by among undergraduates at Caltech. About 95 per cent never competed in any varsity sport in high school, and half of the students didn't even go to a high school athletic contest as a *spectator*.

Competing in varsity sports at Caltech means a considerable sacrifice in both time and money to the student. Until recently, football candidates had to give up summer jobs and then pay their own room-and-board in order to report to school two weeks early to go out for the football team. The athletic department has at least been able to wangle room-and-board for these boys.

Getting the kids to turn out for the team, however, is only the first step in the peculiar series of problems faced by coaches at Caltech. Always, they have to compete with the classroom, and at Caltech all disputes are resolved in favor of the classroom.

Several years ago, Caltech had an All-Conference tackle, a strapping youngster whose mere presence on the field could change the glaze over the eyes of the coaching staff to a gleam of hope of better things to come. This boy had a five o'clock class three days a week, so he made football practice only half the time. No one ever suggested dropping him from the team and, God knows, no one suggested he drop the five o'clock class, either. There was also a sprint man on the track team recently who kept falling asleep in his starting chocks. It turned out that for weeks he had been getting up at 3 o'clock each morning to study so he could spare the time to work out with the track squad.

A lot of apocryphal stories that are repeated gleefully and periodically in sports columns have understandably grown up around Caltech's athletic program. The coaching staff, accustomed to them by now, takes the wisecracks in reasonably good humor.

A typical story is the one about the physics major who was playing tackle on the football team. He figured out during a game that if he changed his angle of attack on an opposing linebacker he could pick off two opponents instead of one. This he did, and Caltech won a smashing triumph, proving that in the long run brains will win out over brawn.

The story isn't true, and, even if it were, Coach LaBrucherie wouldn't buy the moral for a minute.

"My players," he says, "probably have the highest IQ average of any team in the country. Judging by our record, this proves plainly that football is more than a game of brains."

"Sure, we'd like to see larger crowds at our games," says Mr. Musselman. "What athletic department wouldn't? Larger crowds and more enthusiasm would help these kids who take the time and make the effort to come out for a varsity team at Caltech. But one thing is sure: Our athletes don't turn out for a team because they want to show off for their girls or get a write-up in the newspaper. They come out just because they want to play."

Which, come to think of it, might not be a bad idea for U.S. football factories which masquerade under the title of universities.

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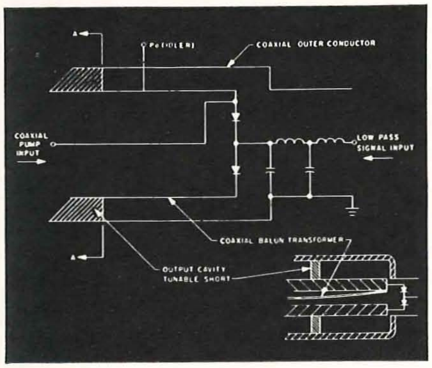
Current-Pumped Abrupt Junction Varactor Power-Frequency Converters

The varactor diode has become well known as an excellent device for low-noise amplification. Recently, however, the varactor diode has been used in high-level frequency converters as both a means of obtaining large amounts of power, tunable over wide bandwidths, and as a means of placing FM and PM information on a CW source, such as a varactor multiplier. The high-level parametric upconverter differs from a low-noise parametric amplifier in the area of conversion efficiency.



Coaxial-Balun Push-Pull Converter

One of the problems in the large signal solution for a varactor frequency converter is the infinite number of terms found when attempting to evaluate the Taylor expansion for charge as a function of voltage for an arbitrary varactor. If one reverses this approach, and finds the expansion for voltage as a function of charge, with a junction exponent, γ, of $\frac{1}{2}$ (abrupt junction varactor), it is found that the series is finite and easily utilized to find a more exact solution for the diode transfer impedance.

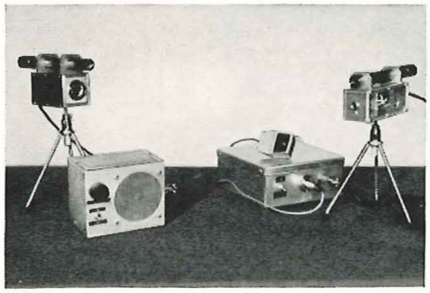
Because of its inherent symmetry, a push-pull application of the diodes provides a large degree of signal isolation, as well as an increase in allowable input power. This type of circuit provides an output at the upper sideband frequency which may be isolated from the pump circuit, by diode balance, without the need for lossy filters. Tunability is readily attained using the appropriate impedance matching networks without the added complications associated with low-loss tunable filters. A low-pass filter is necessary in the signal port to prevent the pump power from being dissipated in the signal circuit.

A simplified representation of a circuit using *only* coaxial networks, is shown in the figure. This particular circuit uses what might be referred to as a section of coaxial-coax. The diodes are pumped in series by means of a balanced transmission line, which may be designed using the techniques available for constructing "balun transformers." The signal is introduced through a low-pass filter and drives the diodes in the push-pull, parallel mode. The resultant idler is generated in a TEM mode, with the conductors acting as a quarter-wave coaxial tuning assembly. The output may be removed using a current probe, coupled to the idler center conductor at the proper impedance tap. The output cavity may be tuned by varying the position of the rear shorting wall (A-A), using sliding finger contacts. With this approach, power levels of several watts have been handled with a conversion loss of 3db compared to power level of several milliwatts with 10db conversion loss for conventional resistive mixers.

Reference—Perlman, B. P., "Current-Pumped Abrupt Junction Varactor Power-Frequency Converters," to be published March 1965, IEEE Transactions on Microwave Theory and Techniques.

Room Temperature GaAs Laser Communications

Communications was among the first applications considered after the invention of the laser. Practical realization of the goal was delayed by the difficulties associated with inefficient energy conversion and inadequate modulation techniques. The discovery of the semiconductor injection laser in 1962 greatly reduced these difficulties, but introduced the restriction of operation under cryogenic conditions. Gallium arsenide injection lasers



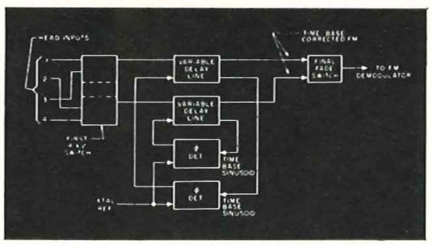
promise energy conversion efficiencies of 20-30%, while modulation of the optical signal can be accomplished simply by modulating the injection current. Early in 1964, the cryogenic restriction was eliminated when efforts of RCA scientists proved successful in discovering a type of gallium arsenide diode which exhibited laser action at room temperature with threshold currents much lower han those previously reported. This discovery permitted the engineering of a room temperature communications link and in May, 1964, such a communications link was demonstrated for the first time. The system employs pulse frequency modulation at a 20 kc repetition rate, has a bandwidth of 5 kc, and can operate in bright sunlight. Ranges up to three miles have been obtained while operating within the atmosphere. Using parallel diodes, a much greater range is feasible. The narrow linewidth of 20 angstroms permits the use of narrow band optical filters thereby reducing background noise. The system is free of radio frequency interference which plagues conventional communication systems, and is so efficient that three nickel cadmium batteries (the size of standard flashlight cells) can provide hours of continuous operation.

Reference—#1. H. Nelson, J. I. Pankove, F. Hawrylo, G. C. Dousmanis, C. W. Reno, "High-Efficiency Injection Laser at Room Temperature," Proc. IEEE (correspondence), Vol. 52, No. 11, p. 1360, Nov., 1964. #2. D. Karlsons, C. W. Reno, W. J. Hannan, "Room Temperature GaAs Laser Voice Communication System," Proc. IEEE (correspondence), Vol. 52, No. 11, p. 1354, Nov., 1964.

15 Megacycle Tape Bandwidth Response

RCA engineers have developed an advanced magnetic recording system with the highest bandwidth response reported to date. This achievement results from integrated efforts in all phases of magnetic recording, such as: air bearing design, high performance servos (50 kc response), precision mechanisms and magnetic head circuitry.

This recent accomplishment is being used in equipment with two 8 Mc bandwidth channels designed for application in a precision radar system. In this design the heads are rotated to achieve 3200 inch-per-second head-to-tape speed in a transverse scan mode. The unit uses a specialized form of a frequency modulated carrier system to achieve a response from 100 cycles per second to 8 Mc. The 3200 IPS head speed permits a wavelength of 0.32 mils at a 10 Mc FM carrier. Head gap lengths of 90×10^{-6} inches are employed to achieve FM response to 15 Mc.



Closed-loop electronically variable delay line system

In order to effect a high reproduction accuracy for radar use, five servomechanisms are employed to insure stability of tape and head motion. The most interesting of these is a pure electronic servo employing the principle of variable delay to remove time displacement errors from the signal. This system employs a 25 to 1 loop gain at a bandwidth of 50 kc. This closed-loop system achieves a time-base accuracy of ± 10 nanoseconds. The rms value of this error is less than 5 nanoseconds, equivalent to less than 5 feet of radar range error, a new standard of excellence for radar recording accuracy.

Reference—F. D. Kell and J. D. Rittenhouse, "Advanced Tape Equipment for Instrumentation Recording," RCA Publ. No. PE-189, containing reprints of 13 technical papers on Magnetic Recording.

These recent achievements in Defense Engineering are indicative of the great range of activities in research, applied research, advanced development, design and development at RCA. To learn more about the many scientific challenges in both defense and commercial engineering awaiting bachelor and advanced degree candidates in Electrical or Mechanical Engineering, Physics, Chemistry or Mathematics, write: College Relations, Radio Corporation of America, Cherry Hill, New Jersey.

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Personals

1926

C. HAWLEY CARTWRIGHT, PhD '30, died of multiple sclerosis on December 19, in Indianapolis, at the age of 60. He had been an industrial consultant in physics for some years. He served as a research fellow at Caltech, the University of Wisconsin, and other universities in Berlin and Brussels. After teaching physics at the University of Michigan and MIT, Dr. Cartwright joined the Corning Glass Works, where he worked on Caltech's 200-inch Hale Telescope. He is survived by his wife, a son, Edgar, and a daughter, Lenni.

1937

GEORGE E. CARROLL died on December 23 of a heart attack at the age of 50. He was a private consultant in structural engineering in Pasadena. After graduation from Caltech, George joined the U.S. Geological Survey, then worked for the Army Corps of Engineers in Los Angeles from 1938 until 1944, when he served as a Seabee officer in the Navy. After the war he worked for various firms as a structural engineer until 1954, when he opened his own office. He is survived by his wife and a 12-year-old daughter, Barbara.

DANIEL G. SCHUMAN, vice president of finance for Bausch & Lomb in New York, has been elected to the company's board of directors. He has been with Bausch & Lomb since 1959. Prior to that he was a manager in the management services division of Price Waterhouse Company, and financial vice president of Stromberg-Carlson.

1939

HERBERT D. STRONG, manager of the technical facilities section at Caltech's Jet Propulsion Laboratory, recently represented JPL at a three-day NASA facility managers conference in New Orleans. He is also currently serving as president of the Caltech Management Club. His daughter, Diane, a third year art major at UCLA, is specializing in environmental design. His son, Davis, is in the 12th grade and is school photographer at La Canada High.

1940

JEROME KOHL is now on the president's staff at the Oak Ridge Technical Enterprises Corporation in Oak Ridge. He has taken over senior staff management with particular emphasis on marketing and product planning. He was formerly coordinator of special products for the General Atomic Division of General Dynamics in San Diego.

1941

JOHN G. SMALL, MS '46, AE '47, is now head of project engineering at Caltech's Jet Propulsion Laboratory. He was formerly deputy chief of JPL's systems planning division, and has been there since 1951.

1943

KLAUS MAMPELL, PhD, is professor of biology at the University of Oregon. He is considered an authority in the field of evolution, and has published some 20 books on scientific, literary, and philosophic subjects.

1944

FRED W. MORRIS, JR., has accepted a government appointment as Associate Director of Telecommunications Management in the Executive Office of the President at The White House in Washington, D.C. The position entails developing guidance and direction of communications for the U.S. Government, and working on problems of satellite communications. Fred is also a member of the professional staff of the National Aeronautics and Space Council. He still retains his private consulting practice — Fred W. Morris, Jr., & Associates — in Palo Alto, and plans to return to it "in a year or so, after having my 'Potomac Fever' cured."

1945

DON R. SWANSON has been dean of the Graduate Library School of the University of Chicago since 1963. He was formerly manager of the Synthetic Intelligence Department of Thompson Ramo Wooldridge, Inc., in Canoga Park.

1948

ARNOLD FELDMAN, MS, assistant professor of radiologic physics at the University of Colorado School of Medicine since 1960, has been appointed to the biophysics staff of the Mayo Clinic in Rochester, Minn.

LEONARD F. HERZOG, II, president of the Nuclide Corporation in State College, Pa., has complete scientific and executive charge of the design and development of a mass spectrometer which will eventually be rocketed to the moon. NASA has awarded the company a $96,429 contract to design the instrument, which can analyze samples of the moon's surface.

1949

RAYMOND A. JOHRDE is now manager of the San Francisco district for the Chicago Bridge & Iron Company. He has been with the company for more than 15 years.

1950

HOWARD E. REINECKE, president of Febco, Inc., in Sun Valley, was elected congressman for the 27th District of L.A. County in November. He ran independently of Barry Goldwater, saying he voted for the GOP presidental candidate, but disagreed with him on certain issues and never sought his endorsement.

ROBERT L. NELSON, MS, PhD '52, has been appointed assistant chief geophysicist of the Pan American Petroleum Corporation at the Tulsa, Oklahoma, general office. He had been district exploration superintendent in Jackson, Mississippi, for the past four and a half years. He has been with Pam Am since 1952.

1959

ROBERT E. HARMON died on December 20 at the Metropolitan State Hospital in Norwalk, California. He did research on rubber at the Brooklyn Polytechnic Institute after graduation from Caltech, then returned to do part-time research at the Institute until 1961. He is survived by his wife, father, and mother.

WILLIAM L. KO, MS, PhD '63, research fellow in materials science at Caltech, is also an artist. He has now opened a private studio in Pasadena to show his paintings of both his native Formosa and of the western U.S. He has been painting since he was five years old, and took lessons from tutors, although he has never attended formal art school.

1960

WOODY BROFMAN, MS, received his PhD in astronautics from the Polytechnic Institute of Brooklyn in June.

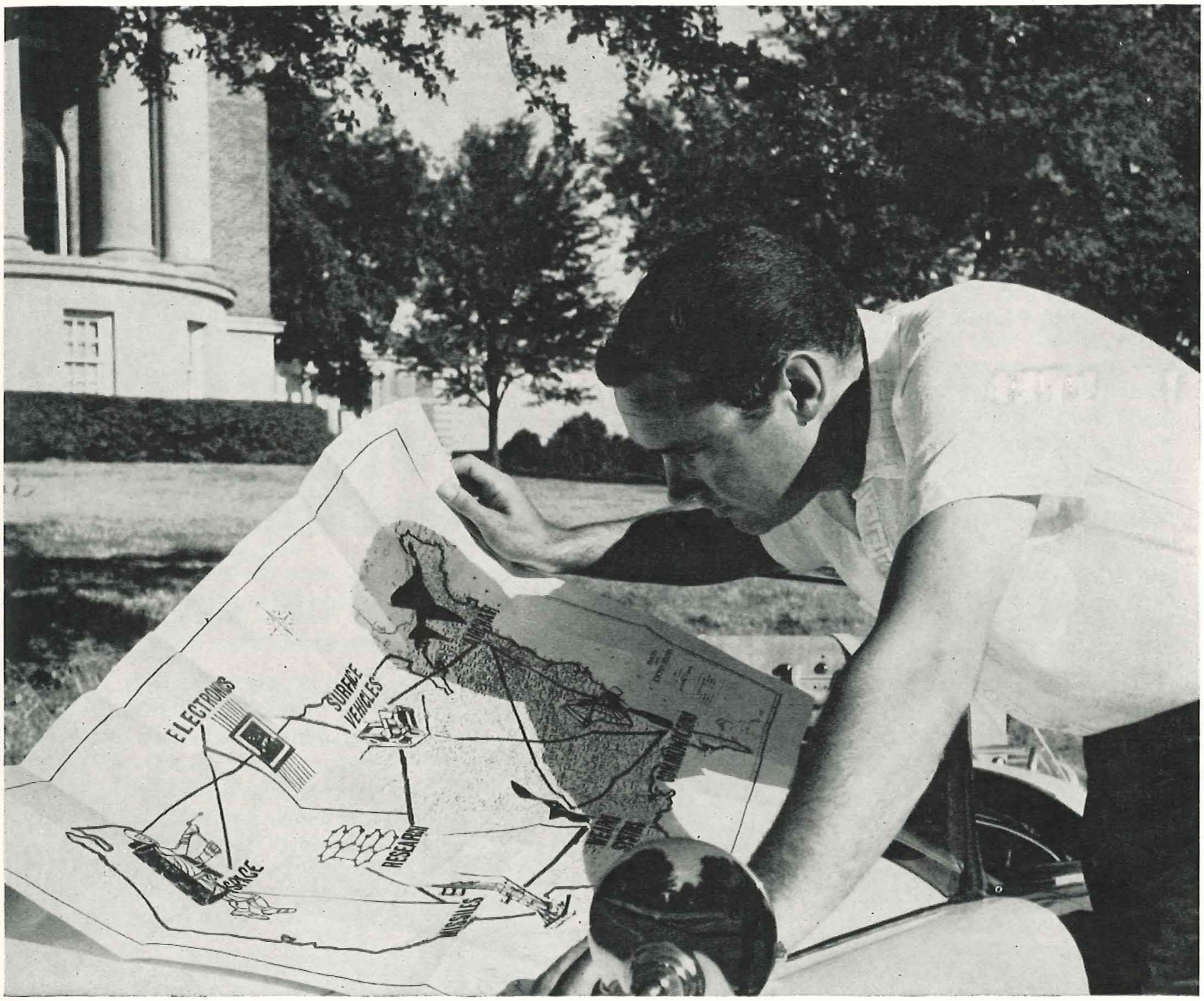
1962

JOHN FISCHER, MS, graduate student at Rensselaer Polytechnic Institute in Troy, N.Y., announces the birth of a son, John Edward, Jr., on September 1.

1963

LIEUT. ALFRED C. PINCHAK, PhD, is a research scientist in the field of energy conversion at the Aerospace Research Laboratories at Wright-Patterson AFB in Ohio.

DONALD M. KING, PhD, is now a research chemist at the DuPont Jackson Laboratory in Wilmington, Delaware. He has just finished a postdoctoral assignment at the University of Texas.



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Alumni News

College Presidents

Four Caltech alumni are now serving as presidents of U.S. colleges or universities. H. Guyford Stever, PhD '41, becomes president of the Carnegie Institute of Technology on February 1. James C. Fletcher, PhD '48, was inaugurated eighth president of the University of Utah in November.

Richard G. Folsom, BS '28, MS '29, PhD '32, has been president of Rensselaer Polytechnic Institute in Troy, New York, since 1958. Kenneth S. Pitzer, BS '35, has been president of Rice Institute in Houston, Texas, since 1961.

Dr. Stever goes to Carnegie Tech from the Massachusetts Institute of Technology, where he has been heading the departments of mechanical engineering, and naval architecture and marine engineering. He has been a member of the MIT faculty since 1941. He is also a member of the Research Advisory Committee of Missile and Space Vehicle Aerodynamics for NASA, and is a trustee of Colgate University, where he did his undergraduate work.

James Fletcher went to the University of Utah from posts as board chairman of Space General Corporation, and systems vice president of the Aerojet General Corporation. He joined Hughes Aircraft in 1948, and in 1954 went to Ramo-Wooldridge as associate director of guided missile research, and director of the Space Technology Laboratories, where the Atlas, Thor, and Titan — America's first ballistic missiles — were developed. In 1958 he organized the Space Electronics Corporation, which merged in 1961 with Aerojet's Spacecraft Division to form the Space General Corporation.

H. Guyford Stever

Outstanding Young Man

James Mercereau, PhD '59, has been named one of the nation's Ten Outstanding Young Men for 1964, by the United States Junior Chamber of Commerce.

Mercereau, principal research scientist for the Ford Scientific Laboratories in Dearborn, Michigan, headed a team of physicists credited with the discovery of a "giant quantum system" which has opened up a whole new area in low-temperature physics.

Beckman President

William F. Ballhaus, executive vice president and a director of the Northrop Corporation, has been elected president of Beckman Instruments, Inc., and a member of the company's board of directors. Arnold O. Beckman, who founded Beckman Instruments in 1935, continues as chief executive officer and assumes the newly-created position of board chairman.

Ballhaus received his PhD degree in aeronautics from Caltech in 1947. He joined Northrop in 1953 as assistant chief engineer for the company's Norair Division. In 1957 he was named a corporate vice president and general manager of Northrop's new Nortronics Division. He was named executive vice president and director in 1961.

Dr. Ballhaus is president of the Greater Los Angeles Chapter of the Association of the United States Army, an advisor to the National Academy of Sciences — National Research Council, and a director of the Electronic Industries Association. He is an associate fellow of the American Institute of Aeronautics and Astronautics, and a member of the American Ordnance Association, the Society of Automotive Engineers, and the National Security Industrial Association.

Dr. Beckman, chairman of Caltech's board of trustees, received his PhD from Caltech in 1928, and taught chemistry here for 14 years before leaving to found Beckman Instruments, Inc.

William F. Ballhaus

Development Director

Richard P. Schuster, Jr., special assistant to the director and deputy director of Caltech's Jet Propulsion Laboratory, has been appointed an associate director of development at Caltech. He will work in the field of corporate relations with E. Curzon Fager, Jr., director of corporation relations.

Schuster received a BS in electrical

continued on page 36

James Mercereau

engineering in 1946 and one in applied chemistry in 1949 from Caltech. After graduation he worked in production for two years at the Long Beach plant of Procter and Gamble, then served as plant manager of the Bray Chemical Company of Los Angeles for ten years. He went to JPL in 1962 to work with the Arms Control Study Group. He has been a director of the Alumni Association since 1963, served as chairman of the Alumni Seminar program committee in 1960, and as general chairman of Seminar Day in 1963.

Schuster replaces Richard Van Kirk '58, who has resigned to be assistant to the plant manager of the Riverside Cement Co., in Oro Grande, California.

"As I prepare to leave the Institute for the second time", Van Kirk writes, "I suddenly wish all alumni could have the opportunity to do as I have done for the past 20 months. Trying to raise money for a famous institution such as Caltech is probably comparatively easy, but it is not easy to be successful at the game. In a period when college costs are rising at a staggering rate – Caltech included – American corporations have been besieged with requests for support from schools of all types, public and private. I have found that often the decision is made in favor of the college with the most competent and vocal alumni in the company's employ. By most vocal I mean those men who sing the praises of their school the loudest and most often.

"So I urge all alumni to stand up and talk about Caltech. Let people know that the school of *your* choice can use some financial aid. After all, if the Institute's stature is diminished for any reason – financial or otherwise – faculty, alumni, administration, and students will all suffer. We cannot disentangle ourselves from some measure of responsibility for the continued excellence of the school from which we received our degrees. I do not intend to disentangle myself merely because I will no longer be in the employ of the Institute."

PLACEMENT ASSISTANCE TO CALTECH ALUMNI

There are two ways in which the Placement Service may be of assistance to you:

(1) To help you seek new employment or a change of employment.

(2) To inform you when outstanding opportunities arise.

This service is provided to Alumni by the Institute. A fee or charge is not involved.

If you wish to avail yourself of this service, fill in and mail the following form:

To: Caltech Alumni Placement Service
California Institute of Technology
Pasadena, California 91109

Please send me:

☐ An Application for Placement Assistance

☐ A form to report my field and operation so that I may be notified of any outstanding opportunities.

Name .... Degree (s) ....

Address .... Year (s) ....

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ALUMNI EVENTS

May 8 Annual Alumni Seminar

June 9 Annual Meeting

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John T. McGraw, '38
Richard P. Schuster, Jr., '46
H. M. Worcester, Jr., '40
Peter, V. H. Serrell, '36

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President	Victor Wouk, '40 Electronic Energy Conversion Corp. 342 Madison Ave., New York 17, N.Y.
Vice-President	Bruno H. Pilorz, '44 75 Echo Lane, Larchmont, N.Y.
Secretary-Treasurer	Harry J. Moore, '48 Old Orchard Road, Armonk, N.Y. 10504

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Vice-President	Francis Morse, '40 16 Reservoir Rd., Wayland, Mass.
Secretary-Treasurer	Thomas C. Stockebrand, '53 56 Summer St., West Acton, Mass.

WASHINGTON, D.C. CHAPTER

Chairman	Willard M. Hanger, '43 4720 Sedgwick St., N.W., Washington, D.C.

CHICAGO CHAPTER

President	Laurence H. Nobles, '49 Dept. of Geology, Northwestern Univ., Evanston, Ill.
Vice-President	Philip E. Smith, '39 Eastman Kodak Co., 1712 Prairie Ave., Chicago, Ill.

SAN FRANCISCO CHAPTER

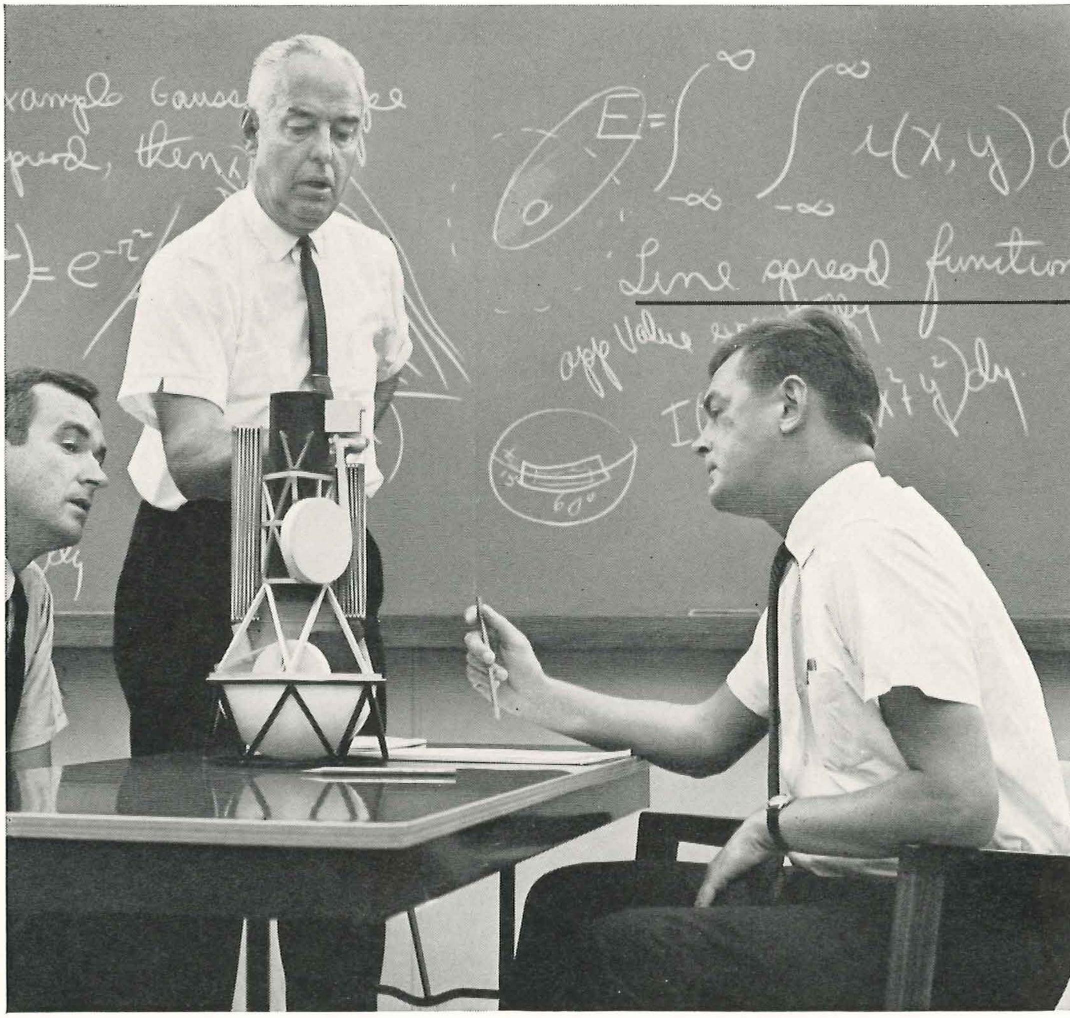
President	Edwin P. Schlinger, '52 G.E. Vallecitos Atomic Lab., Pleasanton, Calif.
Vice-President	Dallas L. Peck, '51 U.S. Geological Survey, Menlo Park, Calif.
Secretary-Treasurer	Thomas G. Taussig, '55 Lawrence Radiation Lab., Univ. of Calif., Berkeley, Calif.

Meetings: 15th Floor, Engineers' Club, 206 Sansome St., San Francisco
Informal luncheons every Thursday at 11:45 A.M.
Contact Mr. Farrar, EX 9-5277, on Thursday morning for reservations.

SACRAMENTO CHAPTER

President	Dudley E. Bennett, '47 4535 Marble Way, Carmichael, Calif.
Vice-President	Harris K. Mauzy, '30 2551 Carson Way, Sacramento 21, Calif.
Secretary-Treasurer	William D. Pyle, '49 3920 Dunster Way, Sacramento, Calif. 95825

Meetings: University Club, 1319 "K" St.
Luncheon first Friday of each month at noon.
Visiting alumni cordially invited—no reservation.



Some M.E.s are going to learn what this means

The mechanical engineer who decides to join forces with us upon completion of his formal education will discover soon enough that the biggest part of his education is still ahead of him. This cliché can be interpreted two ways.

The literal way—"Line spread function" mathematizes certain aspects of image structure in optical theory. Very few mechanical engineers shelter behind academic ivy long enough to get that deep into other men's games. If, for example, we need mechanical engineers capable of communicating with our optical physicists for a common purpose—and we have such purposes in our little-known but heavy aerospace commitments—we had better provide the right fertilizer for ivy ourselves. So we do. Some of the more sophisticated current ideas on what constitutes engineering have strong partisans among the men from whose ranks a newcomer can pick his boss here.

The hard-boiled way—The nice part about being an engineer here is that a man can find a level of sophistication to suit his interests even without risking the shifting sands of international policy. We are plainly, frankly, proudly, and gloriously commercial. We need men to whom to teach the technical subtleties of making money from satisfying the everyday needs of people and of business. When done properly, it can be as challenging to the intellect as the work of the engineer across the road who gets the same signature on his paycheck for ideas on palpating the moon.

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